REGULATION OF RESPIRATION: NON-CHEMICAL REGULATION (NERVOUS)

INTENDED LEARNING OBJECTIVES (ILOs)

By the end of this lecture the student will be able to:

1. Illustrate the functions of medullary and pontine centers concerned with generation and regulation of normal respiratory rhythm.
2. Explain how the normal respiratory rhythm is generated.
3. Explain regulation of ventilation through afferents from respiratory system

RESPIRATORY CENTERS

Spontaneous respiration is produced by rhythmic discharge of impulses from respiratory control centers in pons and medulla.

The rhythmic discharge is regulated by chemical regulation (changes in PO_2, PCO_2 and H^+ concentration) and nervous regulation

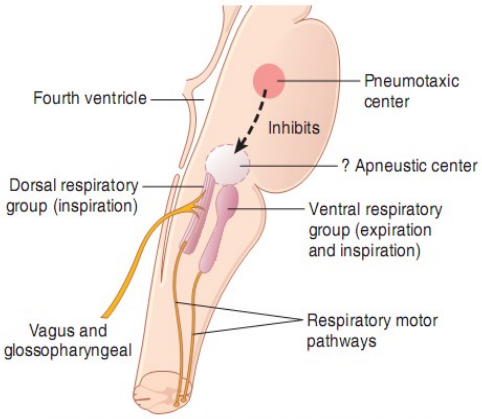


Figure 42-1. Organization of the respiratory center.

A. Medullary respiratory center:

- Dorsal respiratory group
- Ventral respiratory group

B. Pontine respiratory center:

- Apneustic center
- Pneumotaxic center

A. Medullary respiratory center:

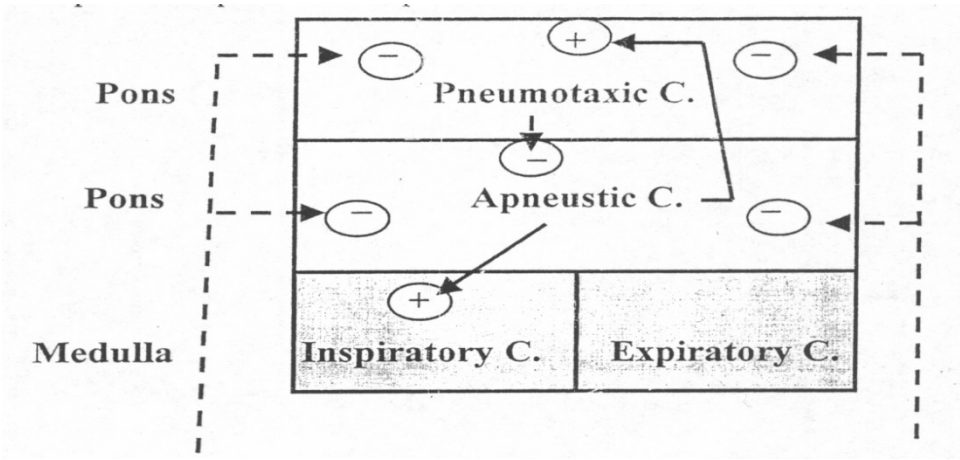
- Dorsal respiratory group (DRG)

Consist of *inspiratory* neurons when it fires the inspiratory muscles contract and when it cease firing, inspiratory muscles relax and expiration begin.

- Ventral respiratory group (VRG)

Contain both *inspiratory and expiratory* neurons

It has no role in normal quiet breathing, it is active only when demands for ventilation increased.



B. Pontine respiratory center:

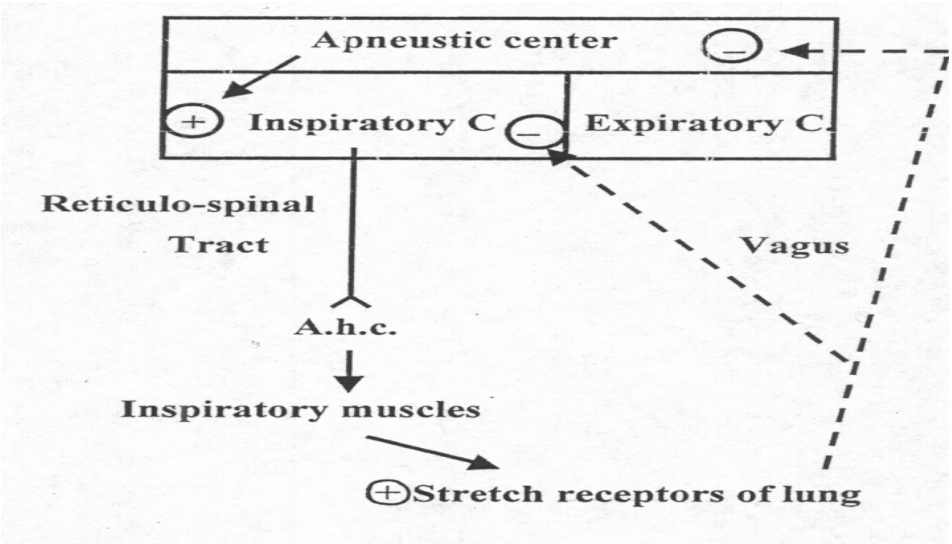
- Apneustic center

It *has driving effect on DRG* of respiration, It stimulates the inspiratory neurons.

Pneumotaxic and vagus nerve inhibit it.

- Pneumotaxic center

Its primarily effect is to limit inspiration, so it increases the rate of breathing



MECHANISM OF EUPNOEA

Normal respiratory rhythm (Eupnoea)

The basic rhythm of respiration is generated mainly in the dorsal respiratory group, other areas in medulla is probably involved like the pre-Bötzinger complex (pre-BÖTC) these areas discharge rhythmically, and they produce rhythmic discharges in phrenic nerve leading to contraction of inspiratory muscles causing stretch of the lung that stimulates the vagus nerve, so inhibition of apneustic center and inspiratory center, expiration occurs passively.

N.B

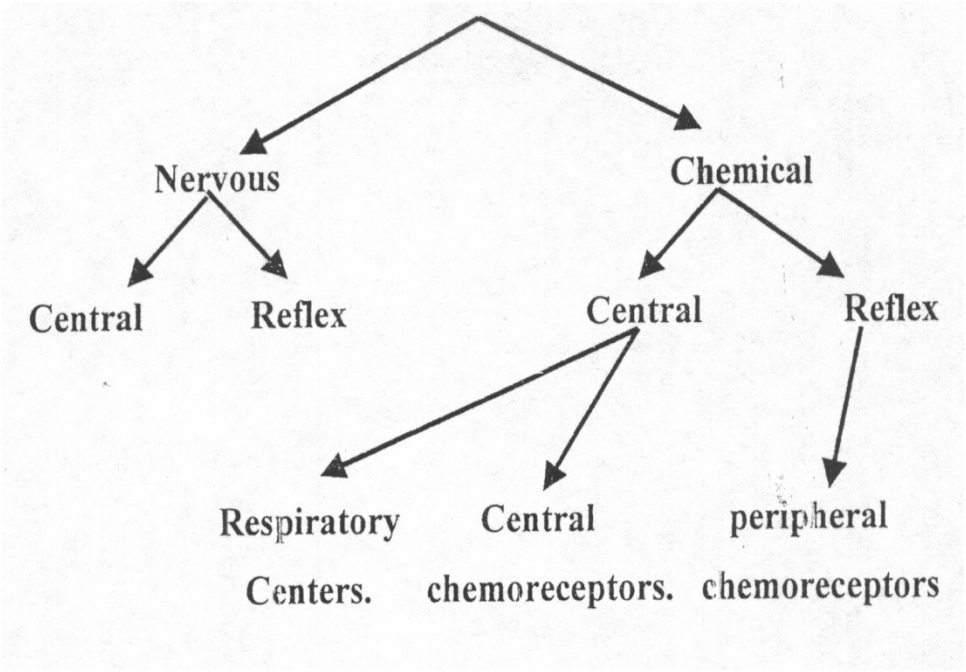
Apneustic breathing:

Deep inspiration followed by shallow expiration after removal of pneumotaxic center and vagus nerve.

Apneusis:

Stoppage of respiration in inspiration, due to cut of vagi after damage to pneumotaxic center which lead to disappearance of all inhibitory impulses._

REGULATION OF RESPIRATION



NERVOUS REGULATION OF RESPIRATION

A) Central:

1) From cerebral cortex: person can voluntary inhibit his respiration for some time after which the breathing can't be inhibited (this point called the breaking point) during voluntary control. Breaking point of breath holding occurs due to CO_2 excess and O_2 lack.

Undine's curse:

Loss of automatic control, without loss of voluntary control. The person could stay alive only by staying awake and remembering to breathe. It may occur in diseases that compresses the medulla.

2) From hypothalamus: during regulation of temperature during hot weather the respiratory center is stimulated.

3) From limbic system: Strong emotions and pain activate the sympathetic system which modulate the rate and depth of respiration.

B) Reflex:

1) Reflexes from respiratory system:

a) Hering Bruer reflex:

The Hering-Breuer inflation reflex is an increase in the duration of expiration produced by steady lung inflation

b) Pulmonary congestion and embolization:

Causes shallow breathing._

N.B: J-receptors:

Sited close to pulmonary capillaries, so j =juxta-pulmonary capillary, stimulated by increase in interstitial fluid (edema) causes rapid shallow breathing may be apnea.

c) Reflexes due to irritation of respiratory passages Cough, sneezing:

Forced expiration in these reflexes help to expel irritants and keep airways clear.

2) Reflexes from arterial baroreceptors:

Increase in arterial blood pressure stimulates baroreceptors leading to decrease in respiratory rate.

3) Reflexes from propriorecptors:

a) In limb: Muscular exercise increases respiratory rate. (**Alam-Smirk reflex**)

b) In intercostals: Send rhythmic discharge to help the respiratory center activity due to the effect of gravity.

4) During vomiting and swallowing

Inhibition of respiration = apnea of swallowing for 2-3 seconds. Hiccup is spasmodic contraction of diaphragm that produces an inspiration**.**

5) Reflexes from right atrial receptors (Harrison's):

Increase Venus return lead to increase in respiratory rate.

6) Sleep:

During sleep there is period of apnea due to decreased sensitivity to CO_2.

Sleep-apnea syndrome:

Prolonged periods of apnea during sleep, which leads to morning headache and fatigue.

Control of Euponea:

1) CO_2
2) Proprioceptors of intercostals.
3) Inflation Herring Breuer reflex_

SUGGESTED TEXTBOOKS

1. Guyton and Hall textbook of medical physiology, thirteenth edition 2016, Elsevier, chapter 42 , from page 539 to 548

2. Ganong's Review of Medical Physiology, twenty-fifth edition 2016, McGraw-Hill Education, chapter 36, from page 655 to 664

3. Lauralee Sherwood Human Physiology: From Cells to Systems, Ninth edition 2016. CENGAGE, chapter 13, from page 479 to 487